IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Dr. Uwe W. Hamm Examiner:

Serial No: Group Art Unit:

Filed: December 6, 2001 Date: December 6, 2001

For: **PROCESS AND DEVICE FOR IN-SITU DECONTAMINATION OF AN EUV-LITHOGRAPHY DEVICE**

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Please amend the application as indicated below before calculation of the application fees as follows:

IN THE SPECIFICATION:

Page 1:

Please replace the first paragraph as follows:

FIELD OF THE INVENTION

The invention concerns a process as well as a device for in-situ decontamination of an EUV lithography device.

Please replace the second paragraph on Page 1 as follows:

BACKGROUND OF THE INVENTION

EUV lithography devices are used in the manufacturing of semiconductor components, e.g. integrated circuits. Lithography devices, which are operated in the wavelength range of extreme ultraviolet (e.g. at a

wavelength of 13.4 nm), have primarily multi-layered systems of molybdenum and silicon, for example, as optical elements. EUV lithography devices display a vacuum or an inert gas atmosphere in their interior, however hydrocarbons and/or other carbon compounds cannot be completely prevented from appearing inside the device. These carbon compounds are split by the extreme ultraviolet radiation, leading to a film of contaminated carbons precipitating on the optical element. This contamination by carbon compounds leads to significant losses in reflectivity on the optical surface, which can have a considerable impact on the cost-efficiency of the EUV lithography process.

Page 4:

Please replace the first paragraph as follows:

SUMMARY OF THE INVENTION

Against this background, the task of the invention submitted is to provide a process, i.e. a device for decontaminating an EUV Lithography device, by which standstill periods are avoided and equipment changes to the EUV lithography device to be cleaned are kept to a minimum.

Page 9:

Please replace the first full paragraph as follows:

BRIEF DESCRIPTION OF THE DRAWINGS

The invention should be explained in more detail using a sample embodiment.

Please replace the third full paragraph as follows:

DETAILED DESCRIPTION OF THE INVENTION

The figure shows a schematic illustration of a sample embodiment, in which the dotted line indicates vacuum recipient 1 within the EUV lithography device, or in larger installations, vacuum recipient 1 in which the EUV lithography device as a whole is set up. Optical element 2 and the quartz crystal microwave 3 are set up within vacuum recipient 1. Optical element 2 involves reflectors with molybdenum–silicon, multi-layered systems for a wavelength of 13.4 nm. At this wavelength, the silicon-wafer is exposed by means of the lithography device.

IN THE CLAIMS:

Please substitute the following claims for the pending claim of the same number.

WHAT IS CLAIMED IS:

1. (Amended) A process for in-situ decontamination of an EUV lithography device with the following steps:
- Measuring a current degree of contamination,
- Comparing the degree of contamination with at least one given threshold value,
- Adjusting an O_2 supply to the lithography device,
- Repeating the above steps,
whereby all the steps are completed during the exposure operation.

2. (Amended) A process according to claim 1, wherein in addition to adjusting the O_2 supply, UV radiation of a wavelength between 150 nm and 300 nm is radiated into the EUV lithography device.

3. (Amended) A process according to claim 1, wherein the degree of contamination is measured with the help of one or several oscillators which react to a change in its surface mass by changing resonance frequency.

4. (Amended) A process according to claim 1, wherein the degree of contamination is determined by reflectivity measurements.

5. (Amended) A process according to claim 1, wherein the degree of contamination is determined ellipsometrically.

6. (Amended) A process according to claim 1, wherein the degree of contamination is determined by measuring a stream of photons.

7. (Amended) A process according to claims 1, wherein the degree of contamination is determined while oxygen is being supplied.

8. (Amended) A process according to claim 1, wherein a precise threshold value is given, whereby exceeding the threshold value results in oxygen in a partial pressure range between $1x10^{-10}$ mbar to $1x10^{-3}$ mbar being added, and in the event that the threshold is not reached, the supply of oxygen being stopped.

9. (Amended) A device for in-situ decontamination of optical elements in an EUV lithography device, comprising: at least one measuring device to measure a degree of contamination of the optical element(s) and a connected control unit, which is connected to a device to supply O_2 to the EUV lithography device, and which is set up to compare the measured degree of contamination with at least one pre-set threshold value, and to control the supply of oxygen in relation to the corresponding comparison results.

10. (Amended) A device according to claim 9, wherein the device has at least one light source for radiation in the wave length range between 150 nm and 300 nm.

11. (Amended) A device according to claim 9, wherein at least one measuring device has at least one quartz crystal microwave set up inside the lithography device.

12. (Amended) A device according to claim 9, wherein the measuring device has at least one additional light source and at least one detector, which are set up within the lithography device.

13. (Amended) A device according to claim 12, wherein a polarizer is set up in the beam path of at least one light source, near the light source, and an analyzer is set up near the detector.

14. (Amended) A device according to claim 9, wherein the measuring device has the means to measure a stream of photons that are connected to an optical element in the EUV lithography device.

15. (Amended) A device according to claims 9, wherein a measuring device connected to the control unit is set up as a residual gas-measuring device.

IN THE ABSTRACT:

Please replace the original Abstract with the following Abstract:

ABSTRACT

EUV lithography devices do indeed have a vacuum or an inert gas atmosphere in their interior, yet the appearance of hydrocarbons and/or other carbon compounds within the device cannot be fully prevented. These carbon compounds lead to the contamination of the optical elements and a resulting loss in reflectivity. In order to counteract this, it has been suggested that while operating the EUV lithography device, the degree of contamination should be constantly monitored, e.g. using quartz crystal microwaves. Depending on the degree of contamination, oxygen is supplied to the interior of the lithography device. The oxygen, in combination with exposure radiation breaks down the contamination while the lithography device is running. The EUV lithography device is thereby equipped with at least one measuring device and a connected control unit, which is connected to the oxygen supply.

The following is a MARKED version of the amended pending claims and specification with all changes shown in conventional comparison.

IN THE SPECIFICATION:

Page 1:

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[Description] FIELD OF THE INVENTION

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Against this background, the task of the invention submitted is to provide a process, i.e. a device for decontaminating an EUV Lithography device, by which standstill periods are avoided and equipment changes to the EUV lithography device to be cleaned are kept to a minimum.

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The figure shows a schematic illustration of a sample embodiment, in which the dotted line indicates vacuum recipient 1 within the EUV lithography device, or in larger installations, vacuum recipient 1 in which the EUV lithography device as a whole is set up. Optical element 2 and the quartz crystal microwave 3 are set up within vacuum recipient 1. Optical element 2 involves reflectors with molybdenum–silicon, multi-layered systems for a wavelength of 13.4 nm. At this wavelength, the silicon-wafer is exposed by means of the lithography device.

IN THE CLAIMS:

Please substitute the following claims for the pending claim of the same number.

[Patent Claims] What is claimed is:

1. (Amended) A process for in-situ decontamination of an EUV lithography device with the following steps:

- Measuring [the] a current degree of contamination,
- Comparing the degree of contamination with at least one given threshold value,
- Adjusting [the] an O_2 supply to the lithography device,
- Repeating the above steps,

whereby all the steps are completed during the exposure operation.

2. (Amended) A process according to claim 1, **[characterized in that]** wherein in addition to adjusting the O_2 supply, UV radiation of a wavelength between 150 nm and 300 nm is radiated into the EUV lithography device.

3. (Amended) A process according to claim 1 [or 2], **[characterized in that]** wherein the degree of contamination is measured with the help of one or several oscillators which react to a change in its surface mass by changing resonance frequency.

4. (Amended) A process according to claim 1 [or 2], **[characterized in that]** wherein the degree of contamination is determined by reflectivity measurements.

5. (Amended) A process according to claim 1 [or 2], **[characterized in that]** wherein the degree of contamination is determined ellipsometrically.

6. (Amended) A process according to claim 1 [or 2], **[characterized in that]** wherein the degree of contamination is determined by measuring a stream of photons.

7. (Amended) A process according to claim[s] 1 [to 6], **[characterized in that]** wherein the degree of contamination is determined while oxygen is being supplied.

8. (Amended) A process according to [one of the claims] claim [from] 1 [to 7], **[characterized in that]** wherein a precise threshold value is given, whereby exceeding the threshold value results in oxygen in a partial pressure range between $1x10^{-10}$ mbar to $1x10^{-3}$ mbar being added, and in the event that the threshold is not reached, the supply of oxygen being stopped.

9. (Amended) A device for in-situ decontamination of optical elements in an EUV lithography device, [including] comprising: at least one measuring device [(3)] to measure [the] a degree of contamination of the optical element(s) and a connected control unit [(4)], which is connected to a device [(5a)] to supply O_2 to the EUV lithography device, and which is set up to compare the measured degree of contamination with at least one pre-set threshold value, and to control the supply of oxygen in relation to the corresponding comparison results.

10. (Amended) A device according to claim 9, **[characterized in that]** wherein the device has at least one light source [(5b)] for radiation in the wave length range between 150 nm and 300 nm.

11. (Amended) A device according to claim 9 [or 10], **[characterized in that]**, wherein at least one measuring device [(3)] has at least one quartz crystal microwave [(3)] set up inside the lithography device.

12. (Amended) A device according to claim 9 [or 10], **[characterized in that]** wherein the measuring device [(3)] has at least one additional light source and at least one detector, which are set up within the lithography device.

13. (Amended) A device according to claim 12, **[characterized in that]** wherein a polarizer is set up in the beam path of at least one light source, near the light source, and an analyzer is set up near the detector.

14. (Amended) A device according to claim 9 [or 10], **[characterized in that]** wherein the measuring device [(3)] has the means to measure a stream of photons that are connected to an optical element [(2)] in the EUV lithography device.

15. (Amended) A device according to claims 9 [to 14], **[characterized in that]** wherein a measuring device connected to the control unit [(4)] is set up as a residual gas-measuring device.

IN THE ABSTRACT:

Please amend the original Abstract as follows:

[Conclusion] ABSTRACT

EUV lithography devices do indeed have a vacuum or an inert gas atmosphere in their interior, yet the appearance of hydrocarbons and/or other carbon compounds within the device cannot be fully prevented. These carbon compounds lead to the contamination of the optical elements and a resulting loss in reflectivity. In order to counteract this, it has been suggested that while operating the EUV lithography device, the degree of contamination should be constantly monitored, e.g. using quartz crystal microwaves. Depending on the degree of contamination, oxygen is supplied to the interior of the lithography device. The oxygen, in combination with exposure radiation breaks down the contamination while the lithography device is running. The EUV lithography device is thereby equipped with at least one measuring device [(3)] and a connected control unit [(4)], which is connected to the oxygen supply [(5a)].

[(Figure)]

Respectfully submitted,

HUDAK & SHUNK CO., L.P.A.

By: Daniel J. Hudak, Jr.
Registration No. 47,669

DJHjr/lb

7 West Bowery Street
Suite 808
Akron, OH 44308-1133
(330) 535-2220
Attorney Docket No.: FMW-SS (CZ 51)